Fiber Identification In Wastewater Effluent Using Polarized Light Microscopy

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Consumer Products
Agriculture
Chemical Industry
→ Wastewater Treatment Plant → Fibers Enter Effluent → Fibers Enter Body of Water → Effects on Aquatic Biota

Introduction

- Key Focus: Synthetic Fibers
- Birefringence: optical property of a material having a refractive index that depends on the polarization and direction of light.
- Fibers from wastewater influent pass through system entering effluent.
- Negative consequences on aquatic biota.

Methods

- Create catalog of known synthetic fibers from various manufacturers.
- For effluent, two approaches were used:
  - Method 1 :Filter 150 mL of raw effluent from Ithaca Area Wastewater Treatment Facility (IAWWTF) onto filter paper using Buchner funnel.
  - Method 2: Used sample that was previously digested using hydrogen peroxide:
    - Heat 40 mL of DI water at $200^{o}C$ for 9 minutes. Then place filter paper along with petri dish at the bottom of a 250 mL beaker. Then stir for 5 minutes at 200 rpm.
    - Scrap sample then recover by pipetting 1000 µl of sample onto depression slide.

Sources

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Kappler A, Windrich F, Loder MGJ, Malanin M, Fischer D, Labrenz M, Eichhorn K-J, Voit B. 2015. Identification of microplastics by FTIR and Raman microscopy: a novel silicon filter substrate opens the important spectral range below 1300 cm.sup.-1 for FTIR transmission measurements. Analytical and Bioanalytical Chemistry. 407(22):6791-.
Stoeffler SF. 1996. A Flowchart System for the Identification of Common Synthetic Fibers by Polarized Light Microscopy. Journal of Forensic Sciences. 41(2):15430J. doi:10.1520/JFS15430J.

Known Fibers and Effluent Samples

Fibers from different manufacturers have different birefringence values (.02-.07).

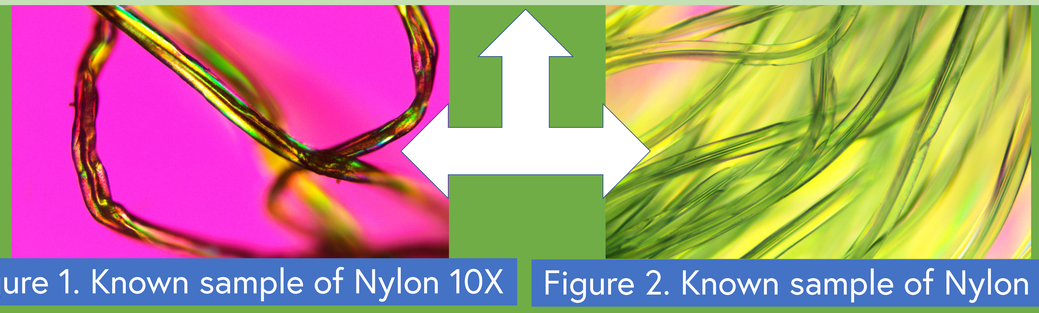

Figure 1. Known sample of Nylon 10X

Figure 2. Known sample of Nylon 10X

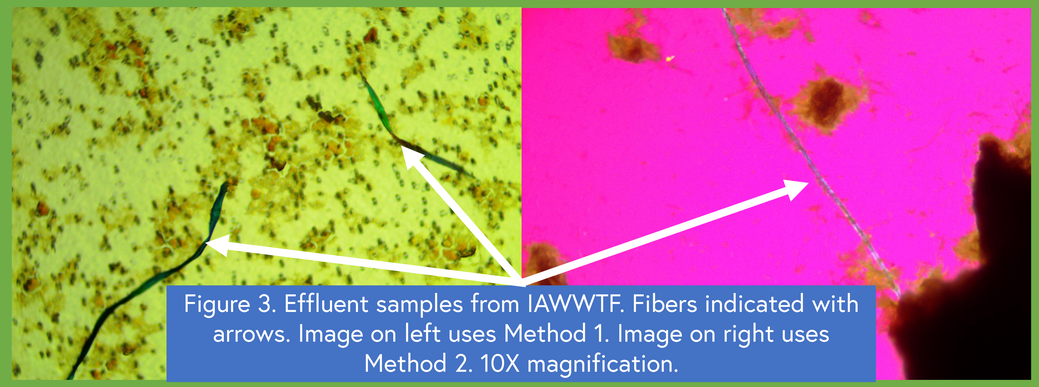

Figure 3. Effluent samples from IAWWTF. Fibers indicated with arrows. Image on left uses Method 1. Image on right uses Method 2. 10X magnification.

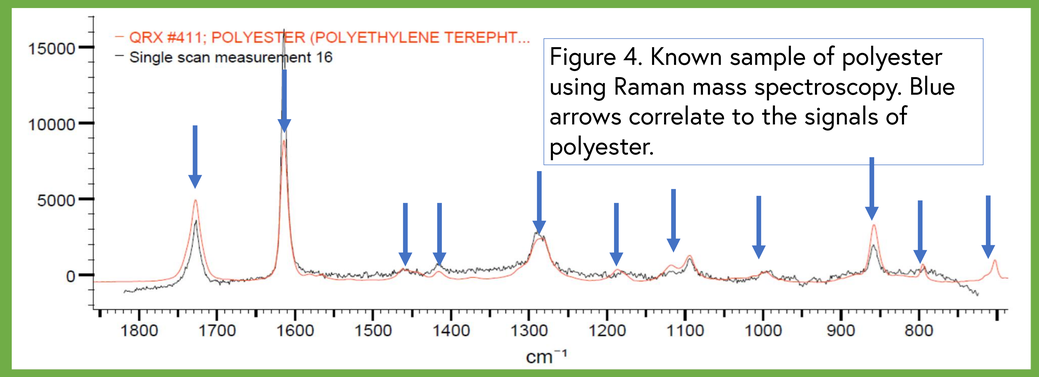

Figure 4. Known sample of polyester using Raman mass spectroscopy. Blue arrows correlate to the signals of polyester.

Results

- Fibers are present in raw and digested effluent.
- Different manufacturers of similar fiber have different color retardation values.
  - Thicker fibers will fall in higher orders. Figure 1. 4th – 5th order. Figure 2. 2nd – 3rd order.
- Fibers can be confirmed through Raman mass spectroscopy.

Discussion

- To fully verify correctness of fiber identification, Raman mass spectroscopy must be utilized on sample.
- Contamination concerns: fibers are everywhere. Extreme cleanliness is required.
- Polarized light will be used for counting fibers, using a grid system. Raman will be used for identification.

Acknowledgments

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